Aquatic Exercises and Stretches to Improve Strength, Balance, and Gait

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**Overview of Aquatic Therapy**

Aquatic physical therapy (APT) is a relatively novel area of practice that is growing exponentially secondary to an increase in the literature related to its success with numerous patient populations. This unique form of therapy includes the scientific and evidence based practice of physical therapy in an aquatic pool under the direction of a licensed physical therapist (PT) or physical therapist assistant (PTA).1 The aquatic environment provides a unique medium that allows for decreased weightbearing that offloads stressed joints, increases movement and stability, decreases fear of falling, and provides multi-directional resistance training without the use of additional equiptment.2

Aquatic physical therapy includes treatment interventions such as therapeutic exercises, functional training, manual therapy, breathing strategies, and fitness using the proprieties of water to assist with treatment. Interventions within the aquatic setting are intended to improve or maintain aerobic capacity and endurance, muscular strength and power, balance and coordination, postural stability, flexibility, agility, body mechanics, gait, and locomotion.3-13 Almost every land-based exercise or stretch can be modified for the aquatic setting. To create a specific treatment intervention that addresses a patient’s specific limitations and deficits, a thorough understanding of common aquatic principles and methods is critical. The main aquatic principles include relative density, buoyancy, hydrostatic pressure, resistance, refraction, and the fluid dynamics of water.14p26-32 Common APT methods include but are not limited to the Halliwick method, Bad Ragaz Ring method, Ai Chi, and Watsu.14ch5-8

Patients across the entire lifespan are appropriate for APT depending on their own unique circumstances. Specific neurologic patient populations that are often treated incorporating APT include cerebral palsy (CP), dementia, multiple sclerosis (MS), cerebrovascular accidents (strokes), Parkinson’s Disease (PD), traumatic brain injuries (TBI), and spinal cord injuries (SCI).4-8,10,12-13 The use of APT may be indicated for patients who have decreased endurance, range of motion, muscular strength, impaired balance and posture, muscle injury, joint pathology, and gait deviations.14p9-10 Aquatic physical therapy is contraindicated when the patient has a fear of water, significant cognitive impairments, behaviors that compromise safety of the patient or therapist, allergy to pool chemicals, medical instability, uncontrolled conditions, active infections, open wounds, contagious rashes, incontinence/colostomy, the presence of a deep vein thrombosis, temperature sensitivity, and a history of autonomic dysreflexia. 14p11,15

The use of APT has many therapeutic and physiological benefits that aid in patient care. The therapeutic benefits of APT include decreased pain sensitivity, muscular relaxation, increased range of motion and flexibility, muscular strength and endurance, increased peripheral circulation, balance, coordination, posture, and patient morale.14ch4,16 Physiologically, when a body is immersed, all body systems are engaged, including the respiratory, cardiovascular, renal, musculoskeletal, neuromuscular, and psychosocial systems. 14ch4 Because APT does not simply have an effect on one area of the body, the following physiological changes occur with submersion: increased respiratory rate, cardiovascular function include heart rate, blood supply to musculature, metabolic rate, and a reduction of blood pressure, edema, cholesterol, insulin, body composition, and the use of medication. 14ch4,16

As APT is becoming an increasingly popular, it is critical for therapist to understand how their services should be billed. The code for APT with Therapeutic Exercise is 97113. 17 It should be noted that code 97113 is a timed billing code (15 minutes). 17 Currently, most insurance policies are based off the Medicare Fee Schedule and Medicare Requirements. As of 2016, Medicare will only pay for skilled and medically necessary APT services that are delivered by a qualified PT or PTA under the supervision of a licensed PT.1,14p18 If a PT aide delivers services or if the patient is performing an independent exercise program (not a skilled PT service), then Medicare will not pay.1 If treatment involves more than one discipline, such as a PT/Occupational Therapy (OT) co-treatment, then only one therapist can bill the entire service or the units must be divided.1 If the PT or PTA is in the pool providing services to multiple patients at one time, then the group therapy exercise code of 97110 must be used and the billing time must corresponded to the time of skilled intervention with each individual patient.1,17

**Literature Review**

As physical therapy has shifted to evidence based practice, the importance of supporting interventions with documented literature has become critical. This section will provide evidence for the use of APT with the neurologic population through literature pertaining to strength training, stretching/spasticity reduction, balance & coordination, gait/locomotion, physical performance & body composition, and the psychological effects of APT.

*Strengthening*

As with land-based activities, APT exercise intensity can be varied by manipulating several components of the exercise or the aquatic environment. For instance, the viscosity of water provides resistance to movement in any direction under the water’s surface. To identify changes in strength after an aquatic exercise program, many studies have used outcome measures with to capture this data. While the study by Kanitz et al.3 and Noh et al.4 are mentioned here, strength is also discussed as components of other studies in this literature review.

In a study by Kanitz et al.3, cardiorespiratory and muscular strength were studied in 34 healthy, elderly, male adults.10 The participants were placed into either an aquatic endurance training group (deep water running only corresponding to endurance training) or an aquatic resistive strength and aquatic endurance-training group that performed both types of exercise in one session. The subjects participated in their assigned exercise program 3 times a week for 12 weeks with progressively increased workloads according to the patient’s threshold. To quantify changes in cardiorespiratory strength, resting heart rate, VO2peak and VO2VT2 (second ventilator threshold), values were obtained during a maximal test on a cycle ergometer before and after the training period. To measure muscular strength, max dynamic 1 repetition max (1RM) and muscular resistance of both the knee extensors and flexors (max reps at 60s 1RM) were taken before and after the training period. The results were positive in both groups for increasing both cardiovascular and muscular strength. In both groups, the resting heart rate decreased significantly and the VO2peak and VO2VT2 had a significant increase (p<0.05). For the endurance and strength-training group, the VO2VT2 resulted in more significant values when compared to the endurance training only group (p<0.05). Both groups demonstrated a significant increase in max dynamic strength of both the knee extensors and local muscular endurance of the knee flexors and extensors. The results of this study indicate that the endurance only group was able to achieve the same statistically significant results in muscular and cardiovascular strength and endurance without specifically focusing on strength training exercise.

To understand the effect of APT on postural balance and muscular strength in chronic stroke survivors, Noh et al.4 investigated 25 ambulatory individuals in a randomized controlled pilot trial. The study participants were randomly allocated to either an aquatic therapy group or a conventional land-based therapy group for 1-hour sessions 3 times a week for 8 weeks. The same muscle groups were focused on in each group, but were addressed via exercises specific to the medium exercises were performed in. For example, the aquatic therapy group focused on balance and weight-bearing exercises while using the Halliwick method and Ai Chi while the conventional therapy group performed gym exercises with free weights and available equipment. To assess for changes, the researchers used the Berg Balance Score, weight bearing ability (measured by vertical ground reaction force during 4 standing tasks: rising from chair and weight shifting forward, backward, and laterally), muscle strength, and gait. After the 8-week intervention, the aquatic therapy group significantly improved their Berg Balance scores, weight being abilities of the affect limbs (forward and backward), and knee flexor strength (p>0.05). The results of this indicate that postural balance and knee flexor strength can be improved in ambulatory chronic stroke survivors though the use of APT, specifically by using the Halliwick and Ai Chi methods.

*Stretching, Spasticity, & Flexibility*

General stretching recommendations indicate that the stretching can be accomplished for all muscles in the aquatic setting and that the stretching intensity should be low to moderate.14p276,18 The therapist can use buoyancy to assist with lifting a limb for stretching purposes under the water. Through proper positioning and form, the therapist can increase the stretch intensity of various muscles. While not specific to physical therapy, the American Academy of Orthopedic Surgeons (AAOS) recommend that stretches be completed both before and after exercise to improve the joint’s range of motion, reduce muscle soreness, and to reduce spasticitiy.18 Furthermore the AAOS states that stretching will improve movement and is especially important for individuals with mental retardation and decreased flexibility secondary to contractures and/or muscle spasms.18 The AAOS also recommends that stretches should be held for 30-60 seconds, longer for individuals who have muscle spasms, and that the stretch should not include bouncing.18

General recommendations addressing spasticity in APT indicate that the aquatic environment is beneficial to reduce spasticity. The natural resistance of the water is advantageous for individuals with neurological impairments because it dampens involuntary spastic movements and tremors.19 Warmer water pools that use a therapeutic temperature of 90-95 degrees Fahrenheit are most beneficial to relax musculature and decrease involuntary movements.19 When working with individuals who have significant weakness, flaccidity, spasticity, or contractures, buoyancy can create a difficult environment to obtain balance when any body part is submerged.19 Flaccid and weak extremities tend to float while spastic and contracted extremities sink.19 For example, if an individual with spasticity is in the supine position in water, then he/she will rotate towards the spastic side because it tends to heavier and tends to sink.

To understand APTs affect on spasticity and the Function Independence Measure (FIM) with subjects who had experienced spinal cord injuries (SCI), Kesiktas and colleagues5 completed a case controlled matched study of 20 subjects. The subjects were divided into 2 groups based on age, gender, time since injury Ashworth scores, intake of oral baclofen, American Spinal Injury Association (ASIA) scores, and FIM scores. Both the control and the experimental group received passive range of motion exercise 2 times per day and oral baclofen for 10 weeks. The experimental group also received an additional 20 minutes of underwater, full immersion aquatic exercise 2 times a week for the duration of the study. The investigators assessed spasm severity, FIM scores, oral baclofen intake, and the Ashworth scale before and after the treatment period. The results of the study indicate that APT increases functional independence, reduces the amount of baclofen needed to control and decrease an individual’s spasticity, and decreases overall spasticity. Both groups obtained a significant increase in FIM scores with the aquatic intervention group having significantly larger increase than the control group (p<0.0001). Only the aquatic intervention group had a significant decrease in oral intake of baclofen. Both groups demonstrated a statistical improvement in their Ashworth scale scores (p<0.01 [control group] and p<0.02 [aquatic intervention group]). Lastly, the subjects in the aquatic intervention group had a significant decrease in spasm severity when compared to the control group (p<0.02). The results of this study can be generally applied to other individuals with spasticity secondary to neurological impairments and can be used to justify the use of APT with these patients.

Plecash et al.2 completed a systematic review to understand if APT would be indicated for 4 neurogenitive disorders: Parkinson’s Disease (PD), Multiple Sclerosis (MS), Amyotrophic Lateral Sclerosis (ALS), and Huntington’s Disease (HD). The authors assessed 4 studies involving subjects with PD and found that after completing APT, significant findings were indicated with the Functional Reach Test, Berg Balance Score, Unified Parkinson’s Disease Rating Score, quality of life, functional mobility, and exercise adherence.7,20-22 The authors found a significantly large body of literature regarding MS (23 studies). The results of these studies indicated that APT is beneficial for individuals with MS because the risk of falling and becoming injured when exercising in water is reduced, as well as a reduction in pain intensity, muscle spasms, spasticity, and fatigue. A decreased in fatigue and increase in quality of life, greater life satisfaction, motor function, maintained or improved strength have all been reported. Three studies reported assessing APT with individuals with ALS and found that APT may be helpful to manage symptoms such as cramps and spasticity, but information is limited to expert opinion and a single care report. Lastly, one case study assessed APT with a 50-year-old man with HD and found it to be beneficial for reducing choreic movements, however no outcome measures were used and results are based off one individual. In summary, this systematic review found that APT is safe, feasible, and has been found to reduce pain and spasticity for individuals with PD and MS. Not enough information has been documented to make conclusions about the affect of APT for individuals with ALS or HD.

In a 2004 study conducted by Driver and colleagues6, fitness was measured before and after an APT program in subjects who had experienced a brain injury. Sixteen individuals participated in the study and were allocated to an aquatic exercise group or the control group. Numerous outcomes were assessed before and after the intervention that are all relevant to this paper including cardiovascular endurance, body composition, muscular strength and endurance, and flexibility. The details of this particular article are discussed in further details in the Physical Performance & Body Composition of this Literature Review. In general, this study found that APT interventions resulted in an increase in physical fitness, and an increase in flexibility and ROM at the shoulders, hips, knees, and ankles, all of which had a significant and positive impact of the functional capacity of individuals living with brain injuries.

*Balance & Posture*

Balance and Posture are excellent deficits to treat in the aquatic environment. In general, water is a helpful medium because buoyancy decreases weightbearing forces and allows for a patient to focus on proper form in a safe and supportive environment without the risk of injury from falls. Vivas and colleagues7 compared postural control and balance with an APT and land-based PT program for individuals with PD. Eleven individuals with stage 2 idiopathic PD were randomly assigned to either a controlled land-based program or the experimental aquatic therapy program. Every participant completed 45-minute sessions twice a week for 4 weeks. Interventions were matched on land and in the pool and based on a specific set of stages and criteria for progressing. The interventions consisted of warm up exercises, trunk mobility exercises, postural stability training, and transferring one’s self and changing body positions. To measure changes, the following tests were administered and assessed at baseline, 4 weeks, and 17 week: the Functional Reach Test, Berg Balance Scale, the Unified Parkinson’s Disease Rating Score (UPDRS), the 5m Walk test, and the Timed Up and Go Test. After the intervention and follow up period, the control group improved in their Functional Reach Test scores while the aquatic intervention group improved their Functional Reach Test, Berg Balance Scale, and UPDRS scores. The results of this study indicate that APT is a safe and effective medium to increase postural control and balance for individuals with PD.

In another randomized pilot study that compared the effects of aquatic therapy and land-based therapy interventions on patients with PD, Volpe et al.8 established similar results. This particular study was a randomized controlled pilot study with 34 subjects who had stage 2.5-3 PD. The patients were assigned to either the aquatic intervention group or the land-based intervention group and completed the program for 1 hour, 5 days a week, for 2 months. This intervention time is vastly different than the previously mentioned Vivas et al.7 study. The aquatic and land-based interventions consisted of a comparable program comprised of a cardiovascular warm up/stretching exercises (10minutes), perturbation-based balance training (40 minutes), and a cool down (10 minutes). The researchers used numerous outcome measures to assess the patient before and after the interventions. Outcome measures included the center of pressure sway recorded with eyes open and closed on a stabilometric platform, the use of the Unified Parkinson’s Disease Rating Scale II and III, the Timed Up and Go test, the Berg Balance Scale, the Activities-Specific Balance Confidence Scale, the Falls Efficacy Scale, the use of a falls diary, and the Parkinson’s Disease Questionnaire-39. The results of the intervention demonstrate significant improvements in all outcome measures with the aquatic intervention group improving more than the land-based intervention group with the following measures: Center of Pressure Sway Area (eyes closed), the Berg Balance Scale, the Activities-Specific Balance Confidence Scale, the Falls Efficacy Scale, the Parkinson’s Disease Questionnaire-39, and the use of the falls diary. The authors obtained a similar conclusion to Vivas et al. in that APT was found to be a safe and effective means to increase balance for individuals with PD and was superior to the same program performed on land.

A study by Avelar and colleagues9 recently investigated the effectiveness of aquatic and land based interventions on static and dynamic balance of elderly individuals. This prospective randomized clinical study involved 46 community-level ambulating elderly adults that were randomized to one of three groups: an aquatic intervention group (n=14), a land-based intervention group (n=15), and a control group (n=17). The intervention groups consisted of 40-minute exercise sessions 2 times a week for 6 weeks. The control group did not alter their daily routine throughout the study while the intervention groups completed a warm up (walking and stretching), lower extremity muscle endurance exercises, and a cool down (walking). Similar to the previous studies, outcome measures utilized and assessed before and after the intervention were the Berg Balance Scale, the Dynamic Gait Index, Gait Speed, and Tandem Gait. The results of this study indicate that lower extremity musculature endurance training significantly increases dynamic and static balance (p<0.05) in community dwelling adults regardless of the training environment. APT interventions were tolerated as well and land-based interventions and resulted in the same improvements.

*Ambulation & Gait Speed*

When the aquatic principles are used to one’s advantage, gait and ambulation can be significantly impacted in a positive manner. A systematic review by Marinho-Buzelli et al.10 investigated the literature regarding the effects of APT on mobility in individuals with neurological diseases. Twenty studies met the researcher’s inclusion and exclusion criteria: 4 randomized controlled trials, 4 non-randomized controlled trials, and 12 before and after tests. The primary objective of this study was to review the effect of APT on mobility with outcomes including bed mobility, reaching, transfers, dynamic balance, wheeling, and ambulation outcomes. The participants in the study generally consisted of individuals with MS, PD and CVA. The most commonly outcome measures analyzed dynamic balance and gait and included the Timed Up and Go, Center of Pressure, the Functional Reach Test, the Functional Independence Measure, and gait speed and kinematics. The results of the study indicate that there is fair evidence to support the use of APT to increase dynamic balance and increase gait speed in individuals with neurological disorders.

*Physical Performance & Body Composition*

Two studies specifically evaluated the effect of APT on physical performance and body composition. Driver et al.6 completed an evaluation of an aquatics program on fitness parameters on individuals with brain injuries in 2004. Sixteen individuals with brain injuries were assigned to either a control group or aquatic intervention group. The control group did change their daily routine while the aquatic intervention group completed aquatic exercises at 50-70% of their max heart rate. The intervention group completed 1-hour sessions 3 times a week for 8 weeks with interventions consisting of aerobic activities, resistant activities, and a combination of aerobic and resistant activities. To evaluate physical fitness, cardiovascular endurance, body composition, muscular strength and endurance, and flexibility were all assessed before and after the intervention. The results of the study indicate that the aquatic intervention group had an increase in all components of physical fitness while the control group did not. The increase in physical fitness positively impacted functional capacity and increased their ability to complete activities of daily living successfully.

In a unique study conducted by Bergamin et al.11, the effects of physical performance and body composition after water or land based exercise in elderly individuals was investigated. Fifty-nine elderly individuals were randomly allocated to either the aquatic intervention group, a land based intervention group, or a non-intervention, control group. The study is unique in that the aquatic therapy was conducted in a geothermal pool over 6 months. All exercise interventions were completed 2 times a week for 6 months and were conducted to improve overall physical function and muscle mass. To measure body composition and physical performance at baseline and after the intervention, the researchers used a variety of outcome measures including knee strength, 8 foot Up and Go Test, the Back Scratch Test, the Sit and Reach Test, and Fat Mass/Body Composition. The results of the study indicate that both exercise groups demonstrated a reduction in the 8 ft Up and Go test and that knee extension strength was maintained. Only the aquatic group demonstrated statistical improvements in the Back Scratch Test (p>0.05), and reduced fat mass by 4% (p>0.05), dominate forearm fat by 9.2% (p>0.05), and increased calf muscle density by 1.8% (p>0.05). All groups, including the control group, improved on scores of the Sit and Reach Test. The aquatic and land-based interventions both resulted in the ability for healthy elderly adults to maintain their strength and improve lower extremity flexibility. It should be noted that only the aquatic intervention improved dynamic balance in addition to improving overall body composition.

*Psychological Effects*

Numerous studies have evaluated APTs effect on quality of life and have indicated a positive correlation.14p40 Surprisingly, only a small number of studies have specifically investigated the psychological effects of APT in individuals with neurological deficits. Neveille et al.12 and Declerick et al.13 both set out to assist with proving information in this realm.

Neville and colleagues12 explored the effect of APT on behavior and psychological well being in people with moderate to severe dementia. Eleven individuals with moderate to sever dementia from two differed aged care facilities received a 12-week aquatic intervention that consisted of exercise for strength, agility, flexibility, balance, and relaxation. To assess the effectiveness of their interventions, the researchers assessed the following outcome measures at baseline, 6 weeks, 9 weeks, and after the intervention: The Psychological Well-Being in Cognitively Impaired Persons Scale (PW-BCIP) and the Revised Memory and Behavior Problems Checklist (RMBPC). After the conclusion of the study, the results indicated statistically significant decreases in both measures. These results suggests that a dementia specific aquatic exercise intervention can reduce behavioral and psychological symptoms associated with dementia and can improve psychological well being in people with moderate to sever dementia.

In a much younger population, Declerick et al.13 investigated the benefits and enjoyment of a swimming intervention for youth with Cerebral Palsy. Fourteen youth (ages 7-17) with a Gross Motor Function Classification level of I-III were randomly assigned to either a control or swimming group. The control group did not alter their daily routine until after the study while the swimming intervention group completed 40-50 minute APT sessions 1 times a week for 10 weeks. To assess the benefits and enjoyment of this intervention the authors specifically chose the following outcome measures to assess at baselines, 5 weeks, 10 weeks, and 20 weeks: level of enjoyment, walking ability, swimming skills, fatigue, and pain. The results of the study were supportive of APT interventions secondary to high level of enjoyment in the treatment group, the fact that pain nor fatigue increased with activity, and that walking and swimming skills improved significantly when compared to the control group (p=0.042; p=0.002 respectively). The authors of this study conclude that APT is recommended for youth with CP to increase their enjoyment with treatment and thus compliance with activity, and to increase their walking/swimming skills.

**Conclusion**

In conclusion, APT is a unique and relatively novel area of physical therapy practice. Aquatic physical therapy is growing secondary to a rising body of literature demonstrating its success with many patient populations. There are many indications, contraindications, therapeutic, and physiological benefits that surround the practice of APT. All body systems are impacted by water immersion and include the respiratory, cardiovascular, renal, musculoskeletal, neuromuscular, and psychosocial systems. Any therapist delivering APT services should be cognizant of and fully comprehend the aquatic principles that include relative density, buoyancy, hydrostatic pressure, resistance, refraction, and the fluid dynamics of water. While interventions can vary greatly in the aquatic environment based on the therapists evaluation, there are 4 common methods of aquatic therapy that include the Halliwick method, Bad Ragaz Ring method, Ai Chi, and Watsu. Lastly, a small but growing body of literature supports the use of APT with the neurological population and includes but is not limited to strengthening, stretching, spasticity, and flexibility, balance and posture, gait and ambulation, physical performance and body composition, and the psychological effects of aquatic therapy.

In summary, APT has been found to be a safe and effective medium to provide therapy in for individuals with neuromuscular limitations and deficits. The evidence is currently limited, but is continuing to grow exponentially each year. As with any therapy, the licensed physical therapist must make the decision if the patient is appropriate for APT and how he/she will use the aquatic principles to specifically tailor the patient’s treatment for their limitations and deficits.

Questions for Debbie

1. When referencing the Plecash systematic review, I understand that I should provide references for 4 studies that discuss PD. Should I also reference the 23 articles that are referenced in conjunction with the data about MS? And the other articles that are mentioned as well?
2. Should I reference each statement in my conclusion?
3. Are my references for the Brody text (both page numbers and chapters) acceptable? Or should I omit all references from the text?

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